

**Table 3. Precipitation associated with selected debris flows in Grand Canyon**

<b>Tributary</b>	<b>River mile -side</b>	<b>Basin area (km<sup>2</sup>)</b>	<b>Date of debris flow</b>	<b>Nearest climate station</b>	<b>Daily precipitation (mm)</b>	<b>Recurrence interval (years)</b>	<b>Storm<sup>1</sup> precipitation (mm)</b>	<b>Recurrence interval (years)</b>
Badger Canyon	7.9-R	47.0	8/18/94	Lees Ferry	45	46	45	16
18-Mile Wash	18.0-L	5.1	8/24/87	Desert View	14	<1	17	<1
Unnamed	19.9-L	3.8	8/24/87	Desert View	14	<1	17	<1
Unnamed	62.5-R	0.7	9/18/90	Desert View	19	<1	61	34
Crash Canyon	62.6-R	1.8	9/18/90	Desert View	19	<1	61	34
Unnamed	63.4-R	0.7	9/18/90	Desert View	19	<1	61	34
Lava Canyon	65.5-L	54.7	12/5/66	Grand Canyon	43	16	118	157
Tanner Canyon	68.5-L	19.3	8/22/93	Desert View	28	3	56	8
Cardenas Creek	70.9-L	3.9	8/22/93	Desert View	28	3	56	8
Unnamed	71.2-R	1.1	8/21/84	Grand Canyon	35	3.2	69	7.6
Unnamed	72.1-R	1.2	8/21/84	Grand Canyon	35	3.2	69	7.6
75-Mile Creek	75.5-L	11.5	8/24/87	Desert View	14	<1	16	<1
			9/18/90	Desert View	19	<1	61	34
Monument Creek	93.5-L	9.7	7/27/84	Grand Canyon	27	1	39	1
Hermit Creek	95.0-L	32.0	7/15/96	Grand Canyon				
Crystal Creek	98.2R	111.6	12/6/66	Tuweep	96	63	157	63
Forster Canyon	122.7-L	10.0	9/8/91	Grand Canyon	13	<1	18	1.9
Fossil Canyon	125.0-L	34.4	8/19/89	Grand Canyon	46	8	92	25
Unnamed	126.9-L	0.6	8/19/89	Grand Canyon	46	8	92	25
Unnamed	127.3-L	0.8	8/19/89	Grand Canyon	46	8	92	25
Unnamed	127.6-L	1.8	8/19/89	Grand Canyon	46	8	92	25
Bedrock Canyon	130.5-R	21.1	8/19/89	Grand Canyon	46	8	92	25
Unnamed	157.6-R	11.1	8/6/93	Peach Springs	20	<1	22	<1
Unnamed	160.8-R	3.4	8/6/93	Peach Springs	20	<1	22	<1
Prospect Canyon	179.4-L	257.2	9/6/39	Grand Canyon	32	7	98	158
			7/24/54	Grand Canyon	27	1	27	--2
			7/24/55	Mount Trumbull	111	100	112	100
			9/17/63	Mount Trumbull	23	<1	23	<1
Unnamed	207.8-L	3.1	3/5/95	Tuweep	43	5	-- <sup>2</sup>	-- <sup>2</sup>
			9/23/91	Peach Springs	35	3	-- <sup>2</sup>	-- <sup>2</sup>
Diamond Creek	225.8-L	716.7	7/20/84	Tuweep	53	10	90	24

<sup>1</sup> Storm is defined as consecutive days with measurable rainfall.

<sup>2</sup> One day storm.

widespread and intense is produced by occasional dissipating tropical cyclones in the late summer and early fall (Smith, 1986), but these storms have only caused debris flows in Prospect Canyon (Melis and others, 1994; Webb and others, 1996).

In general, moisture and storm systems travel across Grand Canyon from west to east and south to north. Strong orographic lifting occurs in the

vicinity of the Kaibab Plateau, with greater rainfall falling at higher elevations (table 1). It should be noted that, although intense or prolonged rainfall is necessary for the occurrence of a debris flow, rainfall alone is not a sufficient cause because a slope failure is also required (Melis and others, 1994). The occurrence of debris flows cannot be predicted solely on the basis of rainfall.



**Figure 8.** Debris-flow source areas exposed in Monument Creek (river mile 93.5-L), Grand Canyon, Arizona. The Supai Group forms the dark, ledgy unit in the middle of the section; the overlying slope is Hermit Shale. The 1984 debris flow was initiated in the Hermit Shale and the lowest member of the Supai Group (Webb and others, 1988).